Sign Vandalism—An Estimate of the National Cost

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Some of the most noticeable vandalism is that which is inflicted on our transportation system signage. This vandalism is not only costly to remove or repair, but it can be dangerous for the users. The Iowa Department of Transportation (Iowa DOT) and Iowa County Engineers Association (ICEA) initiated a grassroots effort to assess the national impact of sign vandalism. This paper presents one part of that effort, which was to estimate the annual national cost of repairing and replacing vandalized signs. The Iowa DOT entered into an agreement with the Center for Transportation Research and Education (CTRE), a center of Iowa State University, to conduct a national survey on sign vandalism. The survey was used to provide the raw data needed to develop the estimate. The surveys were distributed to city, county, and state transportation agencies. The objective of the survey was to identify sign vandalism rates that could be used to estimate the annual national cost of sign vandalism. The correlation between attribute pairs was measured using the simple linear regression. The analysis showed that acceptable rates existed for the number of signs per lane mile, the percent of signs that are vandalized, and the average cost per sign replacement. The rates were then used with the total lane miles of roads nationally to estimate the annual national cost at $274 million per year. Key words: cost, sign(s), survey, vandalism.

INTRODUCTION

Vandalism in general causes untold amounts of damage annually. Vandalism is seen in every aspect of our lives—on the transit bus, on railcars, in public rooms, and in other public places. One of the most noticeable areas is the vandalism that is inflicted on our transportation system signage. Everyone has known of signs that have been knocked down, stolen, written on with graffiti, shot, or damaged in some other way. This paper summarizes an effort to use a national survey to estimate the annual national cost of repairing and replacing vandalized signs.

Sign vandalism can include destruction of the sign or supports, mutilation of the sign face, or theft of the sign and/or supports. Past studies have been conducted and several articles written on the subject of sign vandalism. These efforts have estimated the national cost to be as much as $50 million annually (*1*). One study estimated as much as $1.5 million at the county level in Iowa alone (*2*). This vandalism is not only costly to remove or repair, but it can be dangerous for the roadway users who depend on proper signage for traffic control and guidance (*3, 4*). One of the first steps to combating the problem of sign vandalism is to determine the severity of the problem by quantifying the annual cost of repairing and replacing vandalized signs.

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Background

The Iowa Department of Transportation (Iowa DOT) and the Iowa County Engineers Association (ICEA) initiated a three-step effort to define the sign vandalism problem, identify corresponding solutions or initiatives, and set a course of action for the future. This paper focuses on the first step and specifically on estimating the national cost of sign vandalism. A full report on the entire sign vandalism project is expected in early 2000.

Objectives

This portion of the sign vandalism project was concerned with defining the sign vandalism problem. The work presented here has two objectives:

- Identify some general rates related to signs and sign vandalism that could be used to estimate the extent of sign vandalism at various jurisdictional levels.
- Use the identified rates to estimate the annual national cost of sign vandalism.

METHODOLOGY

In order to assess the national cost impact of sign vandalism, a national survey was designed, distributed, and evaluated. The results of that survey were then used to estimate a national cost. The Center for Transportation Research and Education (CTRE), a center of Iowa State University, provided staff to conduct the survey. The survey went to city, county, and state transportation agencies and asked for raw data related to signs and sign maintenance. The data were used to develop general rates, which, in turn, were used to estimate the cost of sign vandalism. Although the survey was not designed to be statistically robust, it did serve the purpose of identifying some useful signing and sign vandalism rates.

Survey Content

The survey was designed as a one-page, self-addressed, postage-paid questionnaire with ten questions relating to signs and sign vandalism. Three of the questions related to the types of vandalism experienced and the type of sign management program used. The other seven questions asked for the following information for the respondent's jurisdiction:

- number of lane miles
- number of signs in place

- total replacement cost of signs in place
- number of signs vandalized annually
- annual cost to repair of replace vandalized signs
- population represented
- number of sign maintenance employees

Survey Distribution

The survey was distributed to as large an audience as possible as shown in Figure 1. The Local Technical Assistance Program (LTAP) national communication network was the backbone for survey distribution and identifying state contacts. There is an LTAP center in each state along with six tribal centers across the nation. The mission of LTAP is to provide technical assistance to local governments. With this close association to local governments, LTAP centers were used to identify local government officials in each state who would respond to the survey. The Iowa LTAP center is located within CTRE. Iowa LTAP/CTRE provided 25 surveys to each LTAP center. Each LTAP center was asked to identify 25 transportation agencies or officials in their respective state and distribute the survey to them. Iowa LTAP/CTRE provided the surveys, the postage for each LTAP center mailing, and the completed survey return postage.

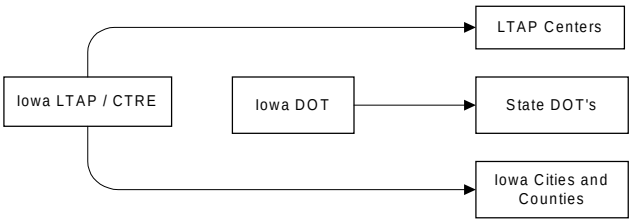

FIGURE 1 Distribution of national survey

The Iowa DOT distributed the survey to all 50 state DOTs and requested that the survey be completed and returned to CTRE. In addition, CTRE mailed the survey to all 99 counties in Iowa and to the 106 cities in Iowa with a population of 3,000 or more. Total survey distribution was approximately 1,700. However, it was not possible to follow up with every agency to make sure the appropriate person actually received and completed the survey.

Survey Response

A total of 196 surveys were returned originating from 36 different states. They included 57 from cities, 117 from counties, 20 from state DOTs, one from a tribal government, and one from a university. During analysis, the data from the tribal center were included in the county data and the data from the university were included in the city data. Although the data set was not as large as anticipated, it did provide enough information to develop general signing and sign vandalism rates.

ANALYSIS

Simple Linear Regression

Simple linear regression was used to identify relationships, or rates, between pairs of variables provided from the survey. Simple linear regression uses a best-fit linear equation ($y = a + bx$) to define the relationship between an independent variable, x, and a dependent variable, y. When a is equal to zero, the relationship is defined by the coefficient b, and can be expressed as a rate. A graphical representation of the he linear predictive model ($y = a + bx$) is shown in Figure 2.

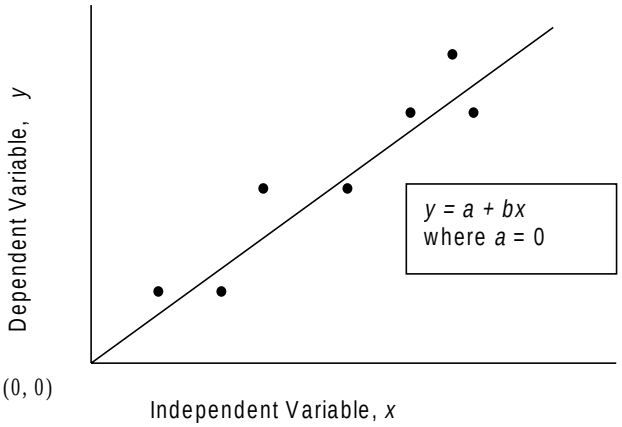

FIGURE 2 Graph of linear predictive model

For each of the relationships analyzed in this report, the dependent variable could not exist without the independent variable. Therefore, all regression lines were forced to pass through the origin ($a = 0$). For example, if x represented the number of lane miles an agency maintained, and y represented the number of signs in place, one could expect that no signs would be in place if no lane miles were maintained, i.e. if x equals zero, then y must equal zero.

In addition to determining linear predictive models, R^2 values were calculated to determine the reliability of each relationship. R^2 is a number between zero and one that can be described as the proportion of variance in y attributable to the variance in x. Table 1 shows the R^2 values for all the relationships that were analyzed.

TABLE 1 R^2 Values for Attribute Pairs

Dependent Variable	Independent Variable				
	Total Signs	Vandalized Signs	Lane Miles	Population	Employees
Repair/ Replacement Cost	0.35	**0.76**	0.06	0.36	
Total Signs			**0.79**	0.33	0.09
Vandalized Signs	**0.49**		0.28	0.26	0.00

Bold type indicates an acceptable relationship

Although seven data fields were requested in the survey, only those shown in Table 1 resulted in data sets suitable for analysis. Due to the wording of the questions and inconsistent data collection methods, there seemed to be confusion on the part of the respondents in providing responses to some of the questions.

The results of the R^2 analysis indicated that three of the attribute pairs showed possible relationships ($R^2 > 0.48$):

- Repair/replacement costs vs. vandalized signs
- Total signs vs. lane miles
- Vandalized signs vs. total signs

Data point plots were prepared for each of the relationships and are shown in Figures 3 through 5. The data points in Figures 3 through 5 are clustered close to the origin (0,0), which indicates that more responses were received from smaller jurisdictions than larger jurisdictions.

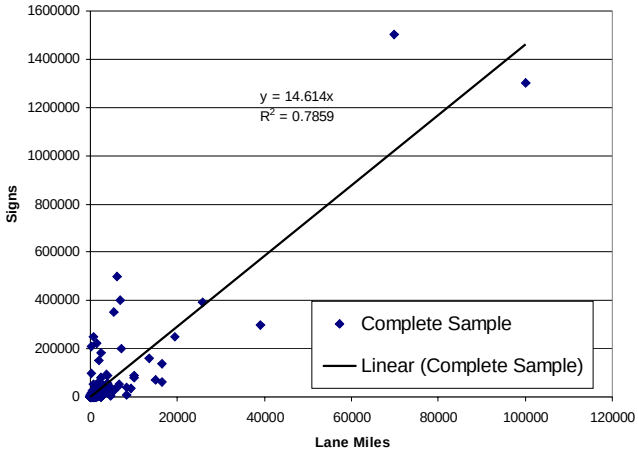

FIGURE 3 Data plot of signs per lane mile

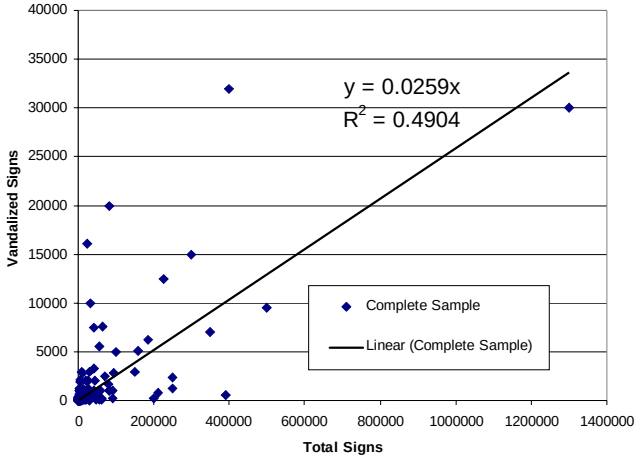

FIGURE 4 Data plot of vandalized signs per total signs

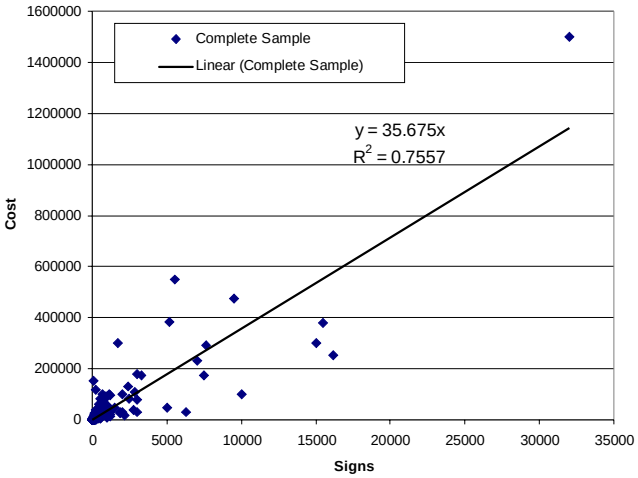

FIGURE 5 Data plot of repair/replacement cost per vandalized sign

The analysis of these three pairs provided rates (coefficient *b*) that could be used to estimate the cost of sign vandalism. The data set was then divided into three jurisdiction levels (city, county and state). Linear regression models were then created for all three data pairs at each jurisdiction level. This resulted in *b* coefficients that could be written as rates for each jurisdiction level.

Survey Results

The results of the linear regression analysis for the complete data set as well as the jurisdictional subsets are shown in Table 2.

TABLE 2 Linear Regression Results - R^2 Values and Linear Coefficients

Attribute pairs	Jurisdiction level	R^2	Linear coefficient, *b*
Signs vs. Lane Miles	All	0.79	14.61
	City	0.72	69.85
	County	0.26	12.19
	State	0.86	14.40
Vandalized Signs vs. Total Signs	All	0.49	0.026
	City	0.73	0.038
	County	0.19	0.018
	State	0.51	0.027
Rep./Repl. Cost vs. Vandalized Signs	All	0.76	35.68
	City	0.74	28.07
	County	0.52	21.97
	State	0.82	42.18

The linear coefficients (*b*) from Table 2 can also be expressed as rates. The following rates are taken from the complete data set and can be applied at the national level:

- 15 signs per lane mile
- 2.6 percent signs vandalized
- $36 for cost of sign repair/replacement (preliminary)
- $85 for cost of sign repair/replacement (final)

The revision of the sign repair/replacement cost will be described later.

NATIONAL SIGN VANDALISM COST ESTIMATE

The rates identified by the survey analysis were then used in the following equation to estimate the annual national cost of sign vandalism:

cost = (signs per lane mile)(% of signs vandalized)(cost of repair/replacement)(lane miles)

The following equations can be used for various levels of government by inserting the rates determined from the analysis:

national cost = (15 signs / lane mile)(2.6% are vandalized)($36/sign)(national lane miles)

city cost = (70 signs / lane mile)(3.8% are vandalized)($28/sign)(city lane miles)

county cost = (12 signs / lane mile)(1.8% are vandalized)($22/sign)(county lane miles)

state DOT cost = (14 signs / lane mile)(2.7% are vandalized)($42/sign)(State lane miles)

If the number of lane miles are known, these equations can be used to make a rough estimate of the cost of sign vandalism for a single jurisdiction or the entire country.

Sign Cost Revision

A second activity conducted during the study was a National Workshop on Sign Vandalism. The national survey analysis had been completed prior to the workshop. As a part of the program for the national workshop, the results of the survey analysis were presented to the attendees and each of the identified rates were discussed and evaluated. The rates of 15 signs per lane mile and 2.6 percent of signs are vandalized were accepted as reasonable numbers. However, the cost of $36 per sign was not considered realistic. The attendees felt that the number was too low and all agreed to adjust it to $85 per vandalized sign. The lower cost figure ($36 per sign) was a result of the survey not being specific enough in asking what should be included in the cost requested. This newer figure ($85 per sign) more than doubled the national sign vandalism cost estimate.

The revised $85 sign cost should be used in each of the previous equations to estimate sign vandalism costs for any jurisdiction level.

Using the revised cost per vandalized sign results in the following calculation of national cost:

Cost = (15 signs / lane mile)(2.6% are vandalized)($85/sign)(8,269,205 lane miles)
= $274,124,145 annually.

Although a larger sample size would have led to more reliable results, an annual national cost estimate was calculated. It should also be noted that the $274 million estimate does not include the additional costs associated with crashes and delays caused by missing or vandalized signs.

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REFERENCES

1. Chadda, H.S. and E.C. Cartwe. Sign Vandalism—Costly and Dangerous National Problem. In Transportation Research Record 926. TRB, National Research Council, Washington, D.C., 1983, pp. 15-24.
2. Bigelow, E. and J. DeLozier. *Sign Vandalism Studies – Counties in Iowa.* March, 1996.
3. Carlron, S. Stop Sign Jury: Evidence Was There. *Tampa Times*. May 16, 1997.
4. Lewis, D. Sign Vandals Make Their Costly – and Deadly – Mark. *Traffic Safety*, National Safety Council. November / December 1998.